APPENDIX IV

Two Control Patents

A. U.S. Patent No. 4,627,177

B. U.S. Patent No. 4,364,189

APPENDIX IV

A. U.S. Patent No. 4,627,177

United States Patent	*4,627,177*
Meyers	**December 9, 1986**

Insole structure

Abstract

A footwear insole member comprising a first portion the area of the upper surface of which approximately underlies the area of the longitudinal arch and a second portion the area of the upper surface of which underlies at least about 10% of the medial area of the heel and from 0 to about 50% of the lateral area of the heel, the border of the area of the upper surface of said second portion including about 10% to about 65% of the outer edge of the heel area, said first and second portions being less compressible than the remaining portions of said member.

Inventors: **Meyers; Stuart R.** (2910 Wallace Ave., Bronx, NY 10467)
Appl. No.: **761662**
Filed: **August 1, 1985**

Current U.S. Class:	**36/43**; 36/91; 36/154
Intern'l Class:	A43B 013/38
Field of Search:	36/43,44,31,32 R,88,93,91 128/595,586,614

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Primary Examiner: Kee Chi; James
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Parent Case Text

This is a continuation of Ser. No. 626,424, filed on July 2, 1984, now abandoned, which is a continuation of Ser. No. 438,389, filed on Nov. 1, 1982, now abandoned.

Claims

What is claimed is:

1. A footwear insole member comprising a first portion the upper surface of which approximately underlies a substantial portion the area of the longitudinal arch and a second portion the upper surface of which underlies at least about 10% of the medial area of the heel and where the second portion extends through substantially the whole of the medial heel, contiguously beyond from about 0% to about 50% of the lateral area of the heel, said first and second portions being contiguous with each other and being contiguous with and less compressible than the remaining portions of said member, the edges of said first and second portions adjacent to said remaining portions undercutting said remaining portions at a downwardly sloping angle of up to about 85.degree. from the vertical to form a wedge which, at its heel end terminus, is entirely in the medial portion of the heel.

2. A member to claim 1 which comprises elastomeric material.

3. A member according to claim 2 wherein said material comprises a microcellular foam structure.

4. A member according to claim 3 wherein said structure is open-celled.

5. A member according to claim 3 wherein said structure is closed-celled.

6. A member according to claim 1 wherein said first and second portions are predominantly formed of material more dense than the material of the remaining portions of said member.

7. A member according to claim 1 wherein said undercutting edges horizontally comprise an approximately S-shaped configuration.

Description

This application is a continuation-in-part of my application Ser. No. 196,020 filed Oct. 10, 1980 which is in turn a division of my application Ser. No. 970,010 filed Dec. 18, 1978 and now U.S. Pat. No. 4,297,797 dated Nov. 3, 1981, the disclosures of which prior applications and patent are incorporated herein by reference thereto.

The "Background and Description of the Prior Art" in lines 9-55 of column 1 of my said patent are applicable to the present application. Reference is also made to the "Reference Cited" in my

said patent. None of the references referred to in my said patent teach the invention disclosed and claimed in said patent or more particularly in this application.

According to the invention described in my said patent, a footwear insole member is provided comprising a medial portion less compressible then the lateral and metatarsal portions whereby the weight of the foot undergoing compression in the lateral and metatarsal portions dynamically forms a medial arch. The member is mainly described as formed of a multiplicity of compressible fluid filled chambers, the variations in compressibility between the medial portion and the remaining portions being achieved by suitable adjustment or selection of the sizes and/or wall thickness and the like of the chambers in the respective portions.

One object of this application and invention is to further elaborate on the functions and advantages of the device disclosed in my U.S. Pat. No. 4,297,797.

Another object of this invention is to provide an insole member which is further improved relative to the insole member disclosed and/or claimed in my said patent.

Still another object of this invention is the provision of an insole member which is more economical and/or simple to make and/or lighter in weight and/or more insulative relative to the insole member of my said patent.

Yet a further object of this invention is the provision of an insole member providing further improvements with respect to comfort, prevention of excessive medial roll of the heel, and/or better or more efficient biomechanical functions relative to the insole member of my said patent.

The attainment of one or more of these and other objects and advantages is made possible by this invention which comprises a footwear insole member comprising a first portion the area of the upper surface of which approximately underlies the area of the longitudinal arch and a second portion the area of the upper surface of which underlies at least about 10% of the medial area of the heel and from 0 to about 50% of the lateral area of the heel, the border of the area of the upper surface of said second portion including about 10% to about 65% of the outer edge of the heel area, said first and second portions being less compressible than the remaining portions of said member.

The means of such attainment is explained in the following description and the accompanying drawings in which:

FIG. 1 is a plan view from above of a preferred embodiment of a left foot insole member of this invention;

FIG. 2 is a medial side view of the insole member of FIG. 1 from the direction of arrow 2;

FIG. 3 is a lateral side view of the insole member of FIG. 1 from the direction of arrow 3; and

FIG. 4 is an enlarged end view of the insole member of FIG. 1 from the direction of arrow 4.

In the several figures of the drawing, like reference characters indicate like parts of said insole member.

Referring to the upper surface area shown in FIG. 1, and in relation to corresponding parts of the (lower surface of the) foot, the broken line joining 10 and 12 generally divides the lateral area of the insole member (completed by the curvilinear line through 16 and 20) from the medial area of the insole member (completed by the curvilinear line through 14 and 18). The area of the metatarsal head and toe portions is generally bound by the lines joining 14, 10 and 16 back to 14. The area A of the longitudinal arch is generally bound by curvilinear lines 18-14 and 14-22 and broken lines 22-18. The medial area B and C of the heel is generally bound by curvilinear line 18-12 and broken lines 12-24 and 24-18. The lateral area D of the heel is generally bound by curvilinear line 20-12 and broken lines 12-24 and 24-20. The outer edge of the heel area is generally defined by the curvilinear line joining 20, 12 and 18.

According to the invention, the aforesaid area A of the longitudinal arch (first portion) and the area B bound by curvilinear lines 18-26 and 26-22 and broken line 22-12 (second portion) generally define the upper surfaces of the portions of the insole member less compressible (e.g. more dense) than the remaining portions of said member; the area B of said second portion constitutes at least about 10% of the aforesaid medial area B and C of the heel and from 0 to about 50% of the aforesaid lateral area D of the heel; and the outer border of the area B of said second portion includes about 10% to about 65% (curvilinear line 26-18) of the aforesaid outer edge of the heel area B, C and D. Curvilinear line joining 26, 22 and 14, shown as being approximately S-shaped, marks the horizontal line of separation between the less compressible portions under areas A and B and the remaining portions of the insole member.

FIG. 2 from the medial side shows, according to a preferred embodiment, the upwardly contoured edge of the longitudinal arch, area A. Also according to a preferred embodiment, the less compressible portion under area A is shown as undercutting the more compressible portion of the metatarsal area along line 14-30 at a downwardly sloping angle E (measured from the vertical line 14--14') to form a wedge indicated by the lines joining 14, 30, and 14'. Angle E shown at 45.degree., preferably may range up to about 85.degree., more preferably from about 20.degree. to about 65.degree..

FIG. 3 from the lateral side shows the upwardly sloping contour of the longitudinal arch under area A.

FIG. 4 from the heel end also shows the upwardly sloping contour of the longitudinal arch area A. The less compressible portion under area B is shown as undercutting the more compressible portion under heel area C in the form of a wedge B' defined by the lines joining 26, 28 and 26' forming a downwardly sloping angle E', (measured from the vertical line 26--26). Angle E', shown as about 45.degree., may preferably range up to 85.degree., more preferably from about 20.degree. to about 65.degree., and may be the same as or different from angle E (FIG. 2), i.e. the angle of the undercutting wedge may vary along the S-shaped line 26-22-14. Alternatively, the portions under areas A and B may have no undercutting wedge borders, i.e. angles E and E' would be 0.degree..

It will be understood that within the scope of my invention variations within the several aforesaid ranges of angles, area values, sizes and positions, etc., and modifications of the preferred embodiments shown, for illustrative purposes only, in the drawing will become obvious, and in some instances advisable or even necessary, to those skilled in the art. By way of example, and depending upon such factors as the type, foot size, foot shape, foot sensitivity, age, etc. of the user, the type of footwear, the activity contemplated, etc., points 16, 20, 26, 18 and 14 may be shifted as deemed advisable in either direction along the periphery of the insole member, the shape and location of the line 26-22-14 may be changed or even rendered non S-shaped, e.g., its intersection at 22 may be shifted in either direction along line 18-20, it may curve into the lateral area, and/or its terminus at 14 may not coincide with the line 16-14 demarking the inner edge of the metatarsal area, the shape and size of the insole member may be varied, etc.

Preferably but not necessarily the lower or bottom surface of the insole member is essentially planar (it may be transversely or longitudinal grooved or ridged) and its upper surface is contoured in approximate conformance with the bottom surface of the foot, and the thickness of the insole member may vary from about 1/8" to about 1.5", preferably generally decreasing from heel to toe and from medial arch to lateral side with suitable cupping in such areas as the heel, lateral side and ball of the foot. The insole member of this invention may be provided for insertion into existing footwear or it may be made part of the original construction of the footwear.

An essential feature of this invention involves the use of more or less compressible or resilient material. This material may be natural or synthetic and solid (non-cellular) or cellular (e.g. foam, sponge, microcellular, macrocellular, honeycombed). The degree of compressibility of these materials may be controlled, adjusted and predetermined in known matter, e.g. density, cell size, cell wall thickness, degree of polymerization and/or cross-linking, etc. Generally elastomeric, examples of such material include latex, natural rubber, butyl rubber, BSR (butadiene/styrene rubber), ABS rubber (acrylonitrile/butadiene/styrene terpolymer), polyurethane, other plastics, copolymers and interpolymers thereof, etc. A microcellular foam structure is preferred which may be closed celled or open-celled (permitting transfer of fluid between cells with shock-absorbing effect under weight-bearing conditions. The cellular material may contain any suitable fluid in its cells, e.g. air or any other gas or water or any other suitable liquid. A polyurethane microcellular foam material is preferred. The less compressible (less resilient, more rigid, etc.) portions in the longitudinal arch and medial heel areas (A and B in the drawing) may be the same or different in chemical composition and physical structure from the remaining portions of the insole member, and are preferably (but not necessarily) contiguous with each other (between the A and B portions and/or between those portions and the remaining more compressible portions, as shown in the drawing. The A and B portions may be more densed, contain smaller cells and/or thicker cell walls, and/or made of an entirely different less compressible material relative to the remaining portions of the insole member.

The insole member may be made in any suitable manner, as by injection molding (double injection, biphase single injection) vacuum or blow molding, etc. using suitable elastomeric material. The A and B portions may be bonded to each other and/or to the remaining portions of the insole member during the molding or other forming operation, or they may be separately made and then assembled by suitable bonding at their peripheries by means of heat and/or

adhesive, etc., or without bonding on a sheet material (disposable or permanent).

The insole member of this invention provides a heretofore unattainable dynamic biomechanical system yielding multiple unexpected advantages in foot and gait control. This system permits the lateral column of the foot to depress in a piston-like action with each step, controls internal torque from the leg (in the first portion of the gait cycle), and redirects the torque of the leg in an external direction by allowing the lateral column of the foot to depress and invert (2nd portion of the gait cycle, slightly before midstance). The novel structure of this insole member for example (1) prevents excessive medial roll of the heel in the first portion of the gait cycle so as to function as a tri plane wedge, and (2) it forces the heel and lateral column of the foot to invert on full weight bearing (as approaching the midstance phase of the gait), thereby stabilizing the foot making it a rigid lever for the propulsive phase of the gait. It provides a piston-like action under weight bearing with each step so that there is a constant return to its original shape after weight-bearing has ceased. It provides a mechanical advantage to the subtalar joint toward supination so that lowering of the lateral column will occur more efficiently and sooner in the gait cycle. The foot therefore becomes a rigid lever at the time it is needed in the gait cycle when full body compression occurs. It limits excessive pronation in the initial portion of the gait cycle and prevents excessive excursion of the posterior calcaneal facet (heel acticulation) thereby preventing excessive migration of the talus (ankle bone) off the calcanaus (heel bone). Since the subtalar joint and the midtarsal joint can only move either clockwise or counter clockwise, the medial contact on the less compressible area will cause the heel to invert, causing the lateral column of the foot to depress and invert. This causes the midtarsal joint to move antagonistically to the supinating subtalar joint and pronate maximally thereby stabilizing the foot. The system allows the plantar fascia to act as a more efficient truss system in metatarsal plantar flexion and stability. It also allows the muscles to functionally contract at mechanical advantages for optimum foot mechanics.

The insole member of this invention is useful in all types of footwear, therapeutic or not, work or play, inactive or active, including for example all types of athletic shoes and boots, walking, jogging and running shoes, army boots, ski shoes, climbing boots, sneakers, slippers, etc.

The invention has been disclosed with respect to preferred embodiments, and various modifications and variations thereof obvious to those skilled in the art are to be included within the spirit and purview of this invention and the scope of the appended claims.

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APPENDIX IV

B. U.S. Patent No. 4,364,189

United States Patent	*4,364,189*
Bates	**December 21, 1982**

Running shoe with differential cushioning

Abstract

A sports running shoe constructed to minimize impact shock and to maximize lateral stability. The shoe's midsole is formed with a medial layer portion having one overall firmness, and a lateral layer portion having a lesser overall firmness.

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Appl. No.: **213207**
Filed: **December 5, 1980**

Current U.S. Class:	**36/31**; 36/29; 36/30R; 36/37; 36/129
Intern'l Class:	A43B 013/16; A43B 021/32; A43B 005/00
Field of Search:	36/31,32 R,30 R,43,44,37,29,129,114 128/581,583-585

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Primary Examiner: Kee Chi; James
Attorney, Agent or Firm: Kolisch, Hartwell & Dickinson

Claims

It is claimed and desired to secure by Letters Patent:

1. Sole means in a sports shoe for absorbing shock on impact, and for producing lateral foot stability when the shoe is used for running, said means comprising

a heel section formed of a resilient material whose overall firmness on the inner side of a longitudinal heel midline axis is greater than that on the outer side of said midline axis, and

a forefoot section formed of a resilient material whose overall firmness on the outer side of a longitudinal forefoot midline axis is substantially the same as that on the outer side of said heel midline axis in said heel section.

2. Sole means in the heel region of a sports shoe for absorbing shock on impact, and for producing lateral foot stability when the shoe is used for running, said means comprising

a first elastomeric slab portion having one density and having its mass distributed primarily on the medial side of the midline axis in such heel region, and

a second elastomeric slab portion having another density which is less than said first density and having its mass distributed primarily on the lateral side of said midline axis.

3. The sole means of claim 2, wherein said slab portions are located in a midsole for the shoe, and meet along a planar interface substantially containing said midline axis.

4. The sole means of claim 3, wherein, with the shoe in an operative position, the plane containing said interface is substantially vertical.

5. The sole means of claim 3, wherein, with the shoe in an operative position, the plane containing said interface slopes downwardly progressing toward the outer side of the shoe.

Description

BACKGROUND AND SUMMARY

The present invention relates to sports shoes, and in particular, to a running shoe constructed to minimize impact shock and to maximize lateral stability.

Extensive clinical evaluation of foot and knee injuries sustained by runners and joggers suggests that the most important factors associated with such injuries are shock absorption on impact and lateral foot stability. Based on injury data, these two factors appear to be of about equal importance. Therefore, both factors should be considered in proposing improvements in sports shoes.

For most runners, initial foot impact occurs in the heel region. Heel cushioning material, which is contained principally in the shoe's midsole of a running shoe has a firmness which provides proper impact cushioning for a person of about average weight. Where the runner is quite heavy, the heel cushioning material may "bottom out" before heel impact is completely absorbed, and shock-related injuries can result. On the other hand, poor lateral foot stability may result in conventionally constructed running shoes if the cushioning material is too soft.

Lateral foot stability refers to a shoe's ability to control the normal tendency of a foot to roll toward its inside on impact. Ideally this inward rolling of the foot, which is known as pronation, is arrested about when the knee is maximally flexed. Where the foot continues pronation after the knee reaches its maximum flexion and has begun to straighten, cumulative knee strain leading to knee injury may occur. As a general rule, prior art running shoes having a relatively firm midsole, particular in the heel region, provide the best lateral stability.

One general object of the present invention is to provide a running shoe having both good shock absorption and lateral stability characteristics.

A more specific object is to provide such a shoe in which the runner's weight, during initial impact, is transferred from softer to firmer cushioning material, to provide effective shock absorption in both light and heavy runners.

Still another object is to provide such a shoe which is constructed to increase lateral foot stability without sacrifice in shock absorption characteristics.

The sports shoe of the present invention includes a sole layer which is formed of an inner side layer portion having one overall firmness and an outer side layer portion having a lesser overall firmness. In one embodiment of the invention, the layer portions are located substantially in the heel region of the layer. In another embodiment, such portions extend substantially throughout the length of the layer.

These and other objects and features of the present invention will become more fully apparent when the following detailed descriptions of preferred embodiments of the invention are read in conjunction with the accompanying drawings, wherein:

FIG. 1 is a side view of a sports shoe having a midsole constructed according to one embodiment of the present invention;

FIG. 2 illustrates, in top plan view, the midsole of the shoe of FIG. 1, removed from the shoe;

FIG. 3 is a sectional view taken along line 3--3 in FIG. 1 further illustrating the shoe's midsole with the same joined to an outsole;

FIG. 4 is a view similar to FIG. 3 showing another embodiment of a running shoe midsole as contemplated by the present invention;

FIG. 5 is a view similar to FIG. 2, illustrating still another embodiment of a midsole contemplated by the present invention;

FIG. 6 is a side view, similar to FIG. 1, showing a sports shoe having a midsole constructed in accordance with yet another embodiment of the present invention; and

FIG. 7 is a view similar to FIG. 2 illustrating, in top plan view, the midsole of the shoe of FIG. 6, removed from the shoe.

DETAILED DESCRIPTION OF THE INVENTION

In FIG. 1 there is shown at 10 a sports shoe constructed according to one embodiment of the invention. Shoe 10 includes a soft foot covering 11 secured to the upper surface of a midsole 12 which joins on its bottom side with an outsole 16. The outsole includes on its base a conventional pattern of generally wedge-shaped lugs, such as lugs 17, which are separated by generally wedge-shaped spaces.

With reference to FIGS. 2 and 3, the shoe, and particularly midsole 12 has an outer, or lateral, side 20 and an inner, or medial, side 22. What might be thought of as an angled longitudinal midline axis in the shoe, indicated by dash-dot line 24 in FIG. 2, extends along the length of the shoe substantially midway between sides 20, 22. Axis 24 includes a heel axis segment 24a which substantially bisects the heel region of the shoe, here indicated at 26, and a forefoot axis segment 24b substantially bisecting the forefoot region of the shoe, which is indicated in FIG. 2 at 28. The shoe expanses on outer and inner sides of axis 24 (upper and lower sides of this axis in FIG. 2) are denoted herein as outer and inner lateral side expanses 30, 32, respectively.

Midsole 12 includes an elastomeric slab portion 34 having the planar shape indicated by cross-hatch shading in FIG. 2, and corresponding roughly to the inner side expanse in the heel region of the shoe. Portion 34, as it appears from the side of the shoe, is indicated also by cross-hatch shading in FIG. 1. As can be appreciated in FIG. 3, the interior edge of portion 34 occupies a vertical plane with the shoe in its normal position, with this plane containing axis segment 24a.

Portion 34, which is also referred to herein as an inner resilient layer portion, is preferably formed of a foamed elastomeric material such as polyurethane. The overall firmness in such material is generally directly related to the material's density. A typical density in portion 34 is one which produces an overall firmness, as measured by a conventional durometer scale of between about 70 and 80-Shore.

Forming the remainder of midsole 12 are upper and lower somewhat L-shaped midsole layers 36, 38, respectively. Layer 36, which has the planar shape shown by the unshaded region of the

midsole in FIG. 2, tapers in thickness toward a front end 39 adjacent the toe of the shoe, as can be seen in FIG. 1. Layer 38, which terminates at a forward end 40 in FIGS. 1 and 2, has the same planar dimensions as that portion of layer 36 which is to the right of end 40 in FIG. 2. Referring to FIG. 3, the interior edges of layers 36, 38, in the heel region of the shoe, abut layer 34 along the above-mentioned vertical plane. The portions of layers 36, 38 coextensive with portions 34 in the heel section of the shoe are also referred to herein, collectively, as an outer resilient layer portion and as an elastomeric slab portion.

Midsole layers 36, 38 are preferably formed of a foamed elastomeric material such as polyurethane. According to an important feature of the embodiment of the invention now being described, layers 36, 38, particularly in the heel region of the shoe, have an overall firmness which is substantially less than that of portion 34. Specifically, layers 36, 38 have densities which produce durometer readings in the range of between about 30 and 35-Shore and about 35 and 45-Shore, respectively. It should be recalled that the durometer reading for portion 34 is about twice these values.

Let us consider now how shoe 10 performs. Perhaps a good way to begin this explanation is to describe generally the mechanics of a "typical" running footfall, and to explain what is meant by shock absorption and lateral stability. The term "typical", as used in the preceding sentence, was placed in quotation marks to reflect the fact that no two footfalls, even with the same runner, are exactly identical.

Considering the fall of a person's right foot during running, the footfall begins with an impact (through a shoe) between the underlying surface and the lateral side of a person's heel. As the footfall progresses, there is an inward rolling of the foot, relative to the axis of the leg, toward the medial side of the foot, and there is a further impact between the underlying surface and the forefoot region of the foot. Thereafter, the foot continues by lifting from the surface.

Shock to the foot, ankle, and leg is considered herein to be substantially vertically directed, and is directly proportional to the rate of vertical deceleration which the foot experiences during a footfall. Sequential impacting of first the lateral heel region in a foot, and thereafter the forefoot region, results in what might be thought of as a dual-peak shock-transmission situation. In other words, vertical foot deceleration tends to maximize in concurrence with these two events. Accordingly, shock absorption and reduction is directly attainable by minimizing the peaks in such peak deceleration.

After the foot has first struck the ground, and when the same begins pronation, there occurs a somewhat oscillatory lateral force transmission between the foot and the underlying surface. In other words, such force transmission will at one moment be directed laterally outwardly, and in another moment medially, and so on. The kind of lateral instability which is considered to be potentially damaging, and which is sought to be avoided, results directly from the degree of pronation which occurs. The greater the amount of pronation, the greater the energy which is absorbed angularly in the ankle, the lesser is the lateral force transmission to the underlying surface, and the greater the instability. Conversely, the lower the amount of pronation, the lower the amount of energy angularly which is absorbed in the ankle, the greater is the force transmission to the underlying surface, and the greater is the stability. Thus, an effort to

maximize lateral stability is one which seeks to minimize pronation and to maximize lateral force transmission to the ground during a footfall.

From the discussion above, it will be apparent that the performance of a shoe during running to minimize shock and lateral stability can be evaluated from force measurements which are made during a runner's footfalls. In a manner which will now be described, such measurements have been made in rather substantial detail with respect to a shoe constructed like shoe 10, as well, in a comparative sense, with respect to several currently available conventional running shoes.

The testing data which appears in the tables below was obtained from the performances of five different subjects, all of them regular runners, wearing each of four different types of shoes. The shoes in the tables are simply identified by Arabic numbers. Shoe-1 was one manufactured by Osaga, Inc., 2468 West 11th, Eugene, Oregon, identified as a model number KT-26. Shoe-2 was exactly the same shoe, except that it was modified in its midsole in accordance with the description above of midsole 12 in shoe 10. Shoe-3 was one manufactured by Nike, Inc., Beaverton, Oregon, and sold under the trade designation Tailwind. Shoe-4 was one made by Adidas, Sportschuhfabricken, 8522 Herzogenaurach, West Germany, Postfach 1120, sold as model number TR-X.

The experimental set up for obtaining data included a conventional force platform interfaced in a well known manner with a conventional computer and with a suitable graphics display system. An acceptable test required that each runner contact the force platform in a normal stride pattern at a designated pace, which was controlled between a 61/2 and a 71/2 minute mile pace using a photoelectric timing system. Platform contact force recording was triggered automatically by the computer.

Tables, I, II and III below relate to shock absorption. Table I, which is entitled "First Maximum Vertical Force Values", includes data obtained from initial lateral heel impact with the platform. Table II, which is labeled "Second Maximum Vertical Force Values", reflects data obtained from forefoot region impact with the platform. Table III shows average vertical force values throughout the total foot platform contact period. The force values presented in these three tables are in normalized units of Newton's per kilogram of subject body mass.

TABLE I

First Maximum Vertical Force Values

Subject	Shoe-1	Shoe-2	Shoe-3	Shoe-4
1	20.3	13.4	20.0	11.3
2	17.6	17.4	19.5	18.0
3	12.8	11.5	13.0	12.1
4	15.2	16.1	13.1	17.1
5	15.2	15.2	16.1	12.8
Mean	16.4	14.7	16.3	14.3

TABLE II

Second Maximum Vertical Force Values

Subject	Shoe-1	Shoe-2	Shoe-3	Shoe-4
1	27.8	15.8	26.0	15.1
2	25.1	25.0	26.4	26.2
3	14.0	11.9	14.9	14.2
4	14.1	14.1	12.5	17.6
5	25.1	24.4	24.3	24.2
Mean	21.2	18.2	20.8	19.5

TABLE III

Average Vertical Force Values for Total Support Period

Subject	Shoe-1	Shoe-2	Shoe-3	Shoe-4
1	15.5	8.7	14.3	8.6
2	14.7	14.3	15.4	15.5
3	8.0	6.8	8.7	8.3
4	8.2	8.3	7.5	10.6
5	14.2	14.0	14.4	14.2
Mean	12.1	10.4	12.0	11.4

In each column of Tables I, II and III, which column pertains to a particular one of the four different tested shoes, there are six data numbers. The first five are the normalized force values measured for each of the five different runners. The sixth and lowest number in each column is the mean number for the column. Referring particularly to the mean numbers presented in these three tables, in table I it is seen that shoes 2 and 4 are closely competitive, and are significantly better heel-impact shock absorbers than shoes 1 and 3. In Table II, the mean numbers clearly indicates superiority of shoe-2 for forefoot impact shock absorption.

The average mean values presented in Table III confirm shoe-2 as being superior in overall shock-absorption characteristics.

Tables IV and V below relate to lateral stability. Table IV which is entitled "Average Medial/Lateral Force Values for 15-45% of Support Period" indicates the direction and magnitude of maximum normalized side-directed forces occuring during the first 15%-45% of the total foot contact time. Table V which is entitled "Average Medial/Lateral Force Values for 30-60% of Support Period" is similar to Table IV, except that it relates to a different particular span of the overall foot-contact time period.

TABLE IV

Average Medial/Lateral Force Values for 15-45% of Support Period

Subject	Shoe-1	Shoe-2	Shoe-3	Shoe-4

1	-70	-50	-29	-5
2	4	-48	-95	-44
3	52	71	45	63
4	-35	-40	4	-24
5	5	-4	48	44
Mean	-9	-14	-5	7

TABLE V

Average Medial/Lateral Force Values for 30-60% of Support Period

Subject	Shoe-1	Shoe-2	Shoe-3	Shoe-4
1	-157	-116	-104	-78
2	-49	-104	-170	-134
3	-28	-22	-57	-41
4	-99	-92	-90	-120
5	-27	-22	-4	-5
Mean	-68	-71	-85	-56

It can be seen that in these two tables both positive and negative force values are recorded. The algebraic signs of these values is simply an indication of the direction in which the recorded forces were applied.

Recalling that maximum lateral force transmission indicates minimal pronation and maximum lateral stability, Table IV, and with reference to the mean force values presented in this table, indicates clear lateral stability superiority in shoe-2. In Table V, shoe-3 appears to be somewhat superior to shoe-2, with both of these shoes being superior in lateral stability performance vis-a-vis shoes 1 and 4.

What the data in these two tables indicates is that, shoe-2 provides significant lateral stability in comparison with the other tested shoes.

Recognizing, as one must, that there is no single running-shoe design which is superior in all respects under all conditions for all runners, test data developed in the comparisons just discussed indicates that a shoe constructed along the lines of shoe 10 tends to produce overall better-shoe performance. In other words, such construction tends to maximize both shock absorption and lateral stability.

Continuing with a description of what is shown in the drawings, FIG. 4 illustrates, in a cross-sectional view similar to that presented in FIG. 3, a midsole 41 constructed in accordance with another embodiment of the invention. As in FIG. 3, the medial side of the midsole is on the right side of FIG. 4. The heel region in midsole 41 is formed of a pair of slab portions 42, 44 having the cross-sectional shapes illustrated in FIG. 4, with each slab having substantially the same longitudinal extents as portion 34 in FIG. 2. Slab portions 42, 44 meet along a planar interface

which slopes downwardly toward the outer side of the shoe. Portion 42 has a density and firmness similar to that of portion 34. Portion 44 has a density and firmness similar to those of previously mentioned layers 36, 38.

A shoe constructed in accordance with FIG. 4 performs with substantially the same overall improved shock absorption and lateral stability characteristics described above for shoe 10.

FIG. 5 shows a midsole 46 constructed according to yet another embodiment of the invention. In midsole 46, a slab portion 48, similar in firmness and density to previously mentioned portion 34 in midsole 12, extends along the full length and depth of the midsole. This portion is distinguished in FIG. 5 by cross-hatch shading. The unshaded portion of midsole 34 has a density and firmness similar to those of layers 36, 38 in midsole 12.

A shoe constructed in accordance with FIG. 5 also performs, in an overall sense, with greatly enhanced shock absorption and lateral stability characteristics.

Describing now still another modification of the present invention, the same is shown in FIGS. 6 and 7. In FIG. 6, a shoe, which is similar in many respects to shoe 10, is shown generally at 50. Like shoe 10, shoe 50 includes a soft foot covering 52 secured to the upper surface of a midsole 54 which joins, on its bottom side, with an outside 56. Outsole 56 is like previously described outsole 16.

As distinguished from the above-described embodiments of a running shoe (according to the invention), whereas differential firmness in these prior-described shoes is achieved through the utilization of slab-like components of different firmness to form a midsole, in midsole 54, firmness differentiation is achieved through providing a unitary homogeneous sole member, or web, 58, in the heel region of the shoe, with this member, on its medial side, having a plurality of substantially horizontally inwardly directed bores, such as bores 60. Fitted in bores 60 are cylindrical plugs, such as plugs 62, that have a firmness which is greater than that of the material forming member 58. As can be seen with reference to FIG. 7, midsole 54 includes an angled longitudinal midline axis 64 which is like previously mentioned axis 24 in midsole 12. Axis 54 includes a heel axis segment 64a which substantially bisects the heel region of the midsole. Bores 60 and 62 extend substantially from the medial side of the midsole to a vertical plane containing axis segment 64a.

One of the advantages of the construction illustrated in FIGS. 6 and 7 is that it offers a high degree of flexibility in forming shoes to accommodate the needs of different runners. More specifically, the preparation of a homogeneous midsole piece which includes bores to receive resilient plugs of differing firmnesses enables a selection to be made at the time that shoe is purchased of the appropriate plugs to suit a runner's requirements. Shoe 50 performs with all of the advantages described earlier with respect to the other shoe embodiments herein.

While several embodiments of the invention have been shown and described herein, it will be appreciated by those skilled in the art that variations and modifications may be made without departing from the spirit of the invention.

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